

errors and other minor modifications (see next bullet), DOE has neither edited nor rewritten the comments submitted. Comments grouped and summarized for response are, of necessity, paraphrased, but DOE made every effort to capture the essence of every comment included in a comment summary.

- DOE did not modify certified transcripts of public hearings. However, some transcripts contained obvious errors (for example, misspelled names or words). For this Comment-Response Document, DOE corrected such errors in the extracted comments. Similarly, DOE deleted extraneous material (such as repeated words) from extracted comments whenever such a deletion would not alter the meaning of the comment. The compact disk included with this Final EIS contains an image of the text of each hearing transcript as certified by the court reporter; if appropriate, the transcript includes an errata sheet noting errors that DOE corrected.
- DOE made every effort to be fully responsive to every comment it received on the Draft EIS and the Supplement. When the meaning of a comment was not clear, DOE made a reasonable attempt to interpret the comment and respond based on that interpretation. In such cases, the response is preceded by a statement of the DOE interpretation of the comment.

An Overview of Key Issues Raised in Comments

This section provides short summaries of a variety of key issues raised by commenters (presented in underlined *italics*) during the public comment process for the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (the Draft EIS) and for the *Supplement to the Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (the Supplement to the Draft EIS). It also provides DOE responses to those key issues. DOE identified the issues as “key” based on factors such as:

- The number of comments received on a particular issue.
- The extent to which an issue concerned fundamental aspects of the Proposed Action.
- The nature of the comments as characterized by the commenters. For example, the U.S. Nuclear Regulatory Commission (NRC or the Commission) categorized its comments into those that DOE should address to complete the Final EIS, those of lower priority that apply to specific topical areas, and those that are for consideration only.
- The extent to which DOE changed the EIS in response to the issue.

The main body of this Comment-Response Document contains all the comments DOE received on the Draft EIS and on the Supplement to the Draft EIS, and the DOE responses to those comments. DOE encourages readers to review the specific comments and DOE responses for particular areas of interest.

I. NUCLEAR WASTE POLICY ACT PROCESS

Why is Yucca Mountain the only site that DOE is studying?

Congress made the decision to focus on the Yucca Mountain site as a potential geologic repository when it amended the Nuclear Waste Policy Act of 1982 (the EIS refers to the amended Act as the NWPA). The Nuclear Waste Policy Act of 1982 provided for a process for selecting

sites for technical study as potential geologic repository locations. In accordance with this process, DOE identified nine candidate sites, the Secretary of Energy nominated five of the nine sites for further consideration, and DOE issued environmental assessments for the five sites. DOE recommended three of the five sites, of which Yucca Mountain was one, for possible study as a candidate repository site. In 1987, Congress amended the Nuclear Waste Policy Act of 1982 directing the Secretary of Energy to perform site characterization activities only at the Yucca Mountain site, and, if the site was found suitable, to make a determination whether to recommend that the President approve the site for development of a repository. A final environmental impact statement must accompany any approval recommendation.

The NWPA specifies that it is not necessary for the EIS to consider the need for a repository, alternatives to geologic disposal, or alternative sites to Yucca Mountain. Although the NWPA does not require an evaluation of alternatives to a repository in this EIS, DOE evaluated a No-Action Alternative to provide a basis for comparison with the Proposed Action.

Why did DOE change its guidelines for determining the suitability of the Yucca Mountain site?

DOE has not amended its general guidelines (10 CFR Part 960) to avoid the elimination of the Yucca Mountain site from consideration. Rather, the purpose of the new Yucca Mountain-specific guidelines (10 CFR Part 963) is to implement the NWPA, given the regulations and criteria of the Environmental Protection Agency (40 CFR Part 197) and the Nuclear Regulatory Commission (10 CFR Part 63), and to provide a technical basis to assess the ability (or performance) of a geologic repository at Yucca Mountain to isolate spent nuclear fuel and high-level radioactive waste from the environment.

The Nuclear Waste Policy Act of 1982 [Section 112(a)] directed the Secretary of Energy (and by extension, DOE) to issue general guidelines for the recommendation of sites for characterization, in consultation with certain Federal agencies and interested Governors, and with the concurrence of the NRC. These guidelines (issued in 1984 at 10 CFR Part 960) were to include factors related to the comparative advantages among candidate sites located in various geologic media, and other considerations such as the proximity to storage locations of spent nuclear fuel and high-level radioactive waste, and population density and distribution.

In 1987, amendments to the Nuclear Waste Policy Act specified Yucca Mountain as the only site DOE was to characterize. For this reason, DOE proposed in 1996 to clarify and focus its 10 CFR Part 960 guidelines to apply only to the Yucca Mountain site (to be codified at 10 CFR Part 963), but never issued these guidelines as final. In 1999, DOE proposed further revisions to the draft Part 963 guidelines for three primary reasons:

- a. To address comments that criticized the omission of essential details of the criteria and methodology for evaluating the suitability of the Yucca Mountain site.
- b. To update the criteria and methodology for assessing site suitability based on the most current technical and scientific understanding of the performance of a potential repository, as reflected in the DOE report, *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998).
- c. To be consistent with the then-proposed site-specific licensing criteria for the Yucca Mountain site issued by the NRC (the Commission has since promulgated criteria at 10 CFR Part 63), and the then-proposed site-specific radiation protection standards issued by the

Environmental Protection Agency (EPA has since promulgated standards at 40 CFR Part 197).

In 2001, DOE promulgated its final 10 CFR Part 963 guidelines to establish the methods and criteria for determining the suitability of the Yucca Mountain site for the location of a geologic repository. These final guidelines are principally the same as those proposed in 1999.

DOE's design has evolved from a primary reliance on the natural barrier system to one that relies on an engineered barrier system. This is inconsistent with the concept of geologic disposal as defined by the Nuclear Waste Policy Act.

The repository design has evolved to reflect ongoing DOE evaluations, design and performance-related reviews by external organizations, such as the Nuclear Waste Technical Review Board, and other influences such as public comments. If the Yucca Mountain site was approved and licensed for construction, the final design would balance the waste isolation abilities and associated uncertainties of the natural system with those of the engineered barrier system, based on an evaluation of their total system performance.

DOE believes that achieving this balance is in keeping with the NWPA. The Act directed DOE to investigate and potentially develop a permanent geologic repository for spent nuclear fuel and high-level radioactive waste in a deep subsurface location that would provide a reasonable assurance of adequate protection for the public and the environment. The Act [Section 121(b)(1)(B)] also directs the use of engineered barriers for a geologic repository at Yucca Mountain by requiring the Nuclear Regulatory Commission to develop criteria that would provide for the use of multiple barriers in the design of the repository. The Act thereby encourages, rather than limits or otherwise prohibits, the use of engineered barriers. The NRC incorporated in its criteria (10 CFR Part 63) the requirement that the repository be predicated on the use of both natural and engineered barriers to enhance the resiliency of the repository and increase confidence that performance objectives will be met.

Why design a repository that would release radioactive materials into the environment?

Given the current state of technology, it is virtually impossible to design and construct a geologic repository that would provide a reasonable expectation that there would never be any releases of radioactive materials. DOE would design, construct, operate and monitor, and eventually close a repository that would meet public health and environmental radiation protection standards and criteria established by the EPA and the NRC. Congress, in the Energy Policy Act of 1992, directed the EPA to develop public health and environmental standards for the protection of the public from releases of radioactive materials stored or disposed of in a repository at the Yucca Mountain site. Congress also directed the NRC to publish criteria for licensing a repository that would be consistent with the radiation protection standards established by the EPA. In part, the EPA standards (40 CFR Part 197) and NRC criteria (10 CFR Part 63) prescribe radiation exposure limits that the repository, based on a performance assessment, must be designed not to exceed during a 10,000-year period after closure.

In the EIS, DOE has evaluated the environmental impacts of the proposed repository's natural and engineered barrier system, which is designed to isolate radioactive materials from the environment for thousands of years. As a result of this evaluation, DOE would not expect the repository to result in impacts to public health beyond those that could result from the prescribed radiation exposure and activity concentration limits during the 10,000-year period after closure.

Further, DOE estimates that the average peak dose to a hypothetical individual from the repository would be substantially less than the dose received from natural background radiation.

II. PUBLIC INVOLVEMENT

Why has DOE ignored the scoping comments from the public? For example, DOE should be considering the lack of emergency response capabilities, the effects of volcanism and transportation, and economic and demographic information on a community-by-community basis.

DOE considered all comments—oral and written—it received during the scoping process for the EIS. More than 500 individuals submitted more than 1,000 comment documents during the 120-day public scoping period, which began on August 7, 1995, and ended December 5, 1995. DOE carefully reviewed the comments, grouped them in categories of common issues or subjects, and responded to all the issues, including the examples cited above, in the *Summary of Public Scoping Comments Related to the Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DIRS 104630-YMP 1997).

The EIS summarizes the primary areas of concern raised by the public's scoping comments. In response to those comments, DOE modified the scope of the EIS to include, for example, additional information and analyses on the disposal of Greater-Than-Class-C low-level waste. However, some of the scoping comments raised issues or concerns that were not germane to the Proposed Action or No-Action Alternative, such as the constitutional basis for disposal in Nevada, or that would have resulted in uncertain or speculative analyses. In the latter case, DOE acknowledged such issues and concerns in the summary of public scoping comments, but did not analyze them in the EIS.

The public comment processes for scoping, the Draft EIS, and the Supplement to the Draft EIS were inadequate because insufficient time was available to provide comments, and public hearings were poorly publicized and held in the wrong locations.

DOE's public involvement process during the development of the EIS is consistent with Council on Environmental Quality and DOE regulations on implementing NEPA, and DOE guidance on public participation during the preparation of EISs.

Before publishing the Notice of Intent to prepare this EIS, DOE notified its stakeholders, the media, Congressional representatives, the Office of the Governor of Nevada, affected units of local government in the Yucca Mountain vicinity, the NRC and other Federal agencies such as the Bureau of Land Management and National Park Service, and the Nuclear Waste Technical Review Board of its plans to prepare the EIS and its approach to the scoping process. In addition, DOE met with 13 Native American tribes and organizations and provided them the same information.

When DOE published the Notice of Intent, it mailed a series of information releases to Yucca Mountain stakeholders notifying them of the opportunity to comment on the scope of the EIS; sent press releases and public service announcements to newspapers and television and radio stations; and made information about Yucca Mountain, the EIS, and the NEPA process available on the Internet (www.ymp.gov) and in public reading rooms across the country. To reach low-income and minority communities, DOE contacted news publications and radio stations that tend

to service these communities to notify them of the scoping meetings and the locations of available information.

In 1995, DOE held 15 public scoping meetings across the country during a 120-day public scoping period. DOE considered each of the comments included in the more than 1,000 documents it received during the scoping process and, in response, included additional information, modified analytical approaches, and evaluated additional implementing alternatives in the Draft EIS. For example, DOE evaluated potential impacts from the transportation and disposal of an expanded inventory, such as Greater-Than-Class-C low-level waste.

During the preparation of the EIS, DOE held discussions with a number of government agencies and other organizations to discuss issues of concern, obtain information for inclusion or analysis in the EIS, and initiate consultations or permit processes. For example, DOE asked the American Indian Writers Subgroup to prepare a document that recorded the viewpoints and concerns of Native Americans about Yucca Mountain and the EIS (see DIRS 102043-AIWS 1998).

DOE distributed 3,400 copies of the Draft EIS to stakeholders and held 10 public hearings throughout Nevada and 11 public hearings elsewhere across the country during a 199-day comment period (August 13, 1999, through February 28, 2000). During the comment period, DOE encouraged stakeholders to offer comments on the document at the public hearings and by mail, facsimile, and the Internet.

Before the public hearings, DOE placed advertisements in local newspapers, including local Spanish-language newspapers, and distributed public service announcements and press releases to more than 175 local and national stakeholders and media outlets to publicize information that would be accessible to the general public and to minority and low-income communities. In addition, in concert with the publication of the Draft EIS, DOE made available Spanish-language fact sheets about Yucca Mountain and the proposed repository.

DOE generally selected locations for public hearings in Nevada based on their proximity to potential transportation routes and the potential repository site, or based on communities having relatively large populations. Given the impracticality of holding hearings at every location potentially affected by the transportation of spent nuclear fuel and high-level radioactive waste, DOE selected national hearing locations in the major metropolitan areas most likely to experience large numbers of shipments or at locations close to nuclear power plants.

In May 2001, DOE issued the *Supplement to the Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, which it distributed to more than 4,000 stakeholders. The Department encouraged these stakeholders to submit comments during a 45-day comment period, which it later extended to 57 days (May 4 through July 6, 2001).

In June 2001, during a review of its mailing records, the Department discovered that it had inadvertently not sent the Supplement to the Draft EIS to about 700 stakeholders who had requested and received a copy of the Draft EIS. DOE acknowledged this oversight, sent the Supplement to the Draft EIS to these stakeholders, and provided them an opportunity to submit comments during a separate 45-day comment period (June 29 through August 13, 2001).

DOE held three public hearings in Nevada during the comment period. It held no hearings outside Nevada because the Supplement focused primarily on matters involving repository design. Commenters were encouraged to submit comments at public hearings and by mail,

facsimile, and the Internet during the comment periods. DOE used means comparable to those it used for the Draft EIS (advertisements, releases, and announcements) to notify the public.

In Volume III of this EIS, DOE has presented and responded to all comments on the Draft EIS and the Supplement to the Draft EIS received by August 31, 2001. In response to comments, DOE has modified the EIS in a variety of ways, including clarifications or changes to the text, new or more recent information (such as 2000 Census data and population projections), and modified analyses (such as those for transportation impacts in which it modified the characteristics of the representative commercial spent nuclear fuel and accident source terms).

DOE's public notices for the Draft EIS were inadequate and should have provided additional meaningful and relevant information, such as a description of the Proposed Action and its implications for people along transportation routes.

DOE designed the advertisements and public notices to provide the public with notice of the availability of the Draft EIS, and the opportunities and ways in which stakeholders could participate in public hearings (at specific locations and times) or provide comments by other means. The notices and advertisements indicated that the EIS evaluates the potential impacts of constructing, operating and monitoring, and eventually closing a repository at Yucca Mountain in Nye County, Nevada, to dispose of our Nation's spent nuclear fuel and high-level radioactive waste. They also indicated that the EIS will help Federal officials make informed decisions, and further informed the reader how interested parties could obtain additional information, including copies of the Draft EIS.

III. EIS ADEQUACY

DOE needs to issue another Draft EIS or a Supplemental EIS because the Draft EIS did not provide sufficient information or analysis, and was substantively and legally deficient. DOE ignored or inadequately considered impacts (such as tourism and gaming, transportation, human health), failed to perform an adequate evaluation of cumulative impacts (contributions of Nevada Test Site activities and environmental contamination), dismissed consideration of Native American impacts and issues, and assessed repository performance and potential environmental contamination using unsubstantiated assumptions, limited and inadequate data, and optimistic interpretations.

Each of the asserted inadequacies is addressed in greater detail elsewhere in this document. In summary, however, DOE believes that the EIS is consistent with NEPA and NHPA requirements. The level of information and analyses, the analytical methods and approaches used to represent conservatively the reasonably foreseeable impacts, and the use of bounding assumptions to address incomplete or unavailable information or uncertainties provide an assessment of environmental impacts consistent with the applicable requirements.

The EIS, which DOE prepared using the best reasonably available data, analyzes a variety of implementing alternatives and scenarios. These alternatives and scenarios reflect potential repository design and operating modes, waste packaging approaches, and transportation options for shipping spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site. DOE included a No-Action Alternative that analyzed two scenarios to provide a basis for comparison with the Proposed Action.

For both the Proposed Action and the No-Action Alternative, the EIS evaluates the affected environment and estimates potential environmental impacts in regions of influence for each

resource area. DOE used information from a broad range of studies to obtain or evaluate the information needed for the assessment of Yucca Mountain as a monitored geologic repository. These include, for example, reports and studies sponsored by DOE, other Federal agencies, the State of Nevada, universities, the National Academy of Sciences, and affected units of local government. In addition, DOE identified the use of incomplete information or the unavailability of information to characterize uncertainties in the data or analytic approaches. DOE acknowledges that the results of analyses often have associated uncertainties, and has described such uncertainties throughout the EIS.

The Draft EIS discussed ongoing site characterization activities and design evaluations, and the potential for resulting changes to repository design. Since the publication of that document, DOE has improved its understanding of the interactions of potential repository features with the natural environment, and the advantages of a number of design features (such as titanium drip shields) to enhance waste containment and isolation. DOE published the *Supplement to the Draft Environmental Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* to provide the updated information to the public. While aspects of the design evolved from those in the Draft EIS, the basic elements of the Proposed Action to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain (such as transportation of spent nuclear fuel and high-level radioactive waste) remained unchanged. For this reason, the Supplement to the Draft EIS was published to address the most recent design enhancements, including various operating modes to manage heat generated by emplaced spent nuclear fuel and high-level radioactive waste. The Final EIS carries forward for impact analysis the repository design described in the Supplement to the Draft EIS.

DOE should have considered a range of alternatives, such as other sites, treatment technologies, and alternatives to geologic disposal.

The NWPA [Section 114(f)(2) and (3)] provides that DOE need not consider in the EIS the need for a geologic repository and alternatives to isolating spent nuclear fuel and high-level radioactive waste in a repository. In addition, the Act provides that the EIS does not have to consider any site other than Yucca Mountain for development as a repository. For these reasons, this EIS does not analyze alternatives other than the Proposed Action and the No-Action Alternative.

In the *Final Environmental Impact Statement, Management of Commercially Generated Radioactive Waste* (DIRS 104832-DOE 1980), DOE evaluated alternatives to mined geologic disposal, including very deep borehole disposal, disposal in a mined cavity that resulted from rock melting, island-based geologic disposal, subseabed disposal, ice sheet disposal, well injection disposal, transmutation, space disposal, and no action. In a 1981 Record of Decision on that EIS, DOE decided to develop mined geologic repositories for the disposal of spent nuclear fuel and high-level radioactive waste.

DOE has failed to define its Proposed Action clearly.

Before the NWPA was enacted, DOE did consider other technological approaches. As stated in the Draft EIS and the Supplement to the Draft EIS, DOE analyzed a variety of scenarios and implementing alternatives that it could implement to construct, operate and monitor, and eventually close a repository at Yucca Mountain. The purpose of these scenarios and implementing alternatives, which reflect potential design considerations, waste packaging approaches, and modes for transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site, was to (1) provide the full range of potential environmental impacts of the

Proposed Action and the No-Action Alternative; (2) reflect potential decisions, such as the mode of transport, that the EIS would support; and (3) retain flexibility in the design of the repository to maintain the ability to reduce uncertainties in or improve long-term repository performance, and improve operational safety and efficiency.

Many of the issues relating to how a repository would be operated and how the spent nuclear fuel and high-level radioactive waste would be packaged would be resolved only in the context of developing the detailed design for a possible License Application, and the subsequent regulatory review of that application. Therefore, DOE cannot predict with certainty how it would eventually resolve these issues. However, to enable an improved understanding of the potential environmental impacts from a more specifically defined Proposed Action, DOE has identified its preferred alternatives, simplified aspects of the Proposed Action, and modified its analyses and presentation of information to illustrate the full range of potential environmental impacts likely to occur under any reasonably foreseeable mode of transportation, or repository design and operating mode. Thus, for example, DOE has identified mostly rail as its preferred mode of transport both nationally and in Nevada, and demonstrated through analysis that the mostly truck and mostly rail national transportation scenarios provide the full range of environmental impacts.

Why didn't DOE identify a preferred alternative or scenario?

In the Draft EIS, DOE indicated its preferred alternative was to proceed with the Proposed Action to construct, operate and monitor, and eventually close a repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. DOE has now identified mostly rail as its preferred mode of transportation, both nationally and in the State of Nevada.

DOE has not identified a preference among the five potential rail corridors in Nevada. If the Yucca Mountain site was approved, DOE would issue at some future date a Record of Decision to select a mode of transportation. Thereafter, for example, if DOE selected mostly rail (both nationally and in Nevada), it would then identify a preference for one of the rail corridors in consultation with affected stakeholders, particularly the State of Nevada. In this example, DOE would announce a preferred corridor in the Federal Register and other media. No sooner than 30 days after the announcement of a preference, DOE would publish its selection of a rail corridor in a Record of Decision. A similar process would occur in the event that DOE selected heavy-haul truck as its mode of transportation in the State of Nevada.

DOE has not identified other preferences under the various scenarios presented in this Final EIS. As noted above, specific details of operating the repository and related features would be resolved only in the context of developing a License Application for review by the NRC.

Why did DOE evaluate a No-Action Alternative that includes unreasonable scenarios?

DOE analyzed the No-Action Alternative to serve as a basis for comparing the magnitude of potential environmental impacts of the Proposed Action. Under the No-Action Alternative, and consistent with the NWPA, DOE would terminate activities at Yucca Mountain and undertake site reclamation to mitigate any significant adverse environmental impacts. In addition, DOE would prepare a report to Congress, with the Department's recommendations for further action to ensure the safe, permanent disposal of spent nuclear fuel and high-level radioactive waste, including the need for new legislative authority. Under any future course that would include continued storage at the generator sites, commercial utilities and DOE would have to continue managing spent nuclear fuel and high-level radioactive waste in a manner that protected public

health and safety and the environment. However, the future course that Congress, DOE, and the commercial utilities would take if Yucca Mountain were not approved remains uncertain.

DOE recognizes that a number of possibilities could be pursued, including continued storage of spent nuclear fuel and high-level radioactive waste at existing sites and/or one or more centralized locations, study and selection of another location for a deep geologic repository, the development of new technologies, or reconsideration of alternatives to geologic disposal. The environmental considerations of these possibilities have been analyzed in other contexts in other documents to varying degrees. Implementation of any of these possibilities likely would require new legislation, the details of which would be speculative at best.

In light of these uncertainties, DOE decided to illustrate the range of potential environmental impacts by analyzing two No-Action Alternative scenarios that could occur without additional legislation—long-term storage of spent nuclear fuel and high-level radioactive waste at the current sites with effective institutional control for at least 10,000 years, and long-term storage with no effective institutional control after about 100 years. Although the Department agrees that neither of these scenarios is likely to occur, it selected them for analysis because they provide a basis for comparison to the impacts of the Proposed Action and because they reflect a range of the impacts that could occur.

IV. EIS-RELATED DECISIONS

DOE cannot base decisions on this EIS.

DOE believes that the EIS adequately analyzes the potential environmental impacts that could result from the Proposed Action or the No-Action Alternative. This belief is based on the level of information and analysis, the analytical methods and approaches used to represent conservatively the reasonably foreseeable impacts, and the use of bounding assumptions where information is incomplete or unavailable, or where uncertainties exist.

For the same reasons, if the site was approved, DOE believes that the EIS provides the environmental impact information necessary to make certain broad transportation-related decisions, namely the choice of a national mode of transportation outside Nevada (mostly rail or mostly legal-weight truck), the choice among alternative transportation modes in Nevada (mostly rail, mostly legal-weight truck, or heavy-haul truck with use of an associated intermodal transfer station), and the choice among alternative rail corridors or heavy-haul truck routes with use of an associated intermodal transfer station in Nevada. However, follow-on implementing decisions, such as the selection of a specific rail alignment in a corridor, or the specific location of an intermodal transfer station in Nevada or the need to upgrade heavy-haul truck routes, would require additional field surveys, State and local government and Native American tribal consultations, environmental and engineering analyses, and NEPA reviews.

DOE already has decided to recommend the Yucca Mountain site.

At the time DOE prepared this Final EIS, it had not made a decision on the proposed repository at Yucca Mountain. The Secretary of Energy will make a determination on whether to recommend the site to the President on the basis of a number of different types of information, including that contained in the Final EIS. Any recommendation would be accompanied not only by the Final EIS, but also by other information designated in Section 114 of the NWSA. This includes a description of the proposed repository, including preliminary engineering specifications for the facility; a description of the proposed waste form or packaging; an explanation of the relationship

between the proposed waste form or packaging and the geologic medium of the site; a discussion of the site characterization data that relate to the safety of the site; preliminary comments of the NRC concerning the sufficiency of information for inclusion in any Departmental License Application; the views and comments of the governor and legislature of any state or the governing body of any affected Native American tribe; comments made by the Secretary of the Interior, the Council on Environmental Quality, the EPA, and the NRC, including comments on the Final EIS; other information considered appropriate by the Secretary; and any impact report submitted by the State of Nevada.

V. SOCIOECONOMICS

Why has DOE restricted the socioeconomic region of influence to three Nevada counties? A restricted region of influence underestimates socioeconomic impacts that would occur in the entire State of Nevada and in individual communities through which DOE could transport materials.

To identify the socioeconomic region of influence, DOE estimated the residential distribution of the future anticipated workforce by considering where current employees associated with the Yucca Mountain Project and the Nevada Test Site now reside. Based on this estimate, about 98 percent of the expected repository workforce would reside in Clark, Lincoln, and Nye Counties. Thus, these would be the counties, if any, that would be expected to experience socioeconomic impacts from the construction, operation and monitoring, and closure of a repository at Yucca Mountain.

Although DOE defined the region of influence as such, it has not limited the socioeconomic analyses to these three counties; it assessed the remaining 14 counties (called the *Rest of Nevada*) taken together. DOE did not report the combined results for the 14 counties in the Draft EIS because collectively their impacts would be much smaller than the already low impacts estimated for the three-county region of influence. In response to comments however, the Final EIS reports the combined results for the Rest of Nevada.

DOE defined the transportation-related region of influence to include Clark, Lincoln, and Nye Counties as well as other counties through which a potential branch rail line or heavy-haul route would pass. The potential transportation-related socioeconomic impacts presented in the EIS focused on the three-county region of influence, but also were reported as an aggregate for the other counties for certain measures commensurate with their relative level of impact (for example, Gross Regional Product).

Why does DOE use outdated population data?

When DOE prepared the Draft EIS, it based the Nevada population estimates on the then-most-recent available information (1996-1997) from the U.S. Bureau of the Census. The Department used these data in its economic and demographic forecasting model (REMI) to project population growth in the regions of influence and to evaluate socioeconomic impacts from the Proposed Action (both repository and Nevada-related transportation). For its transportation health and safety analyses, however, DOE relied on 1990 population data, which were the then-most-recent data incorporated in the standard models used for such analyses.

In general, the Bureau of the Census is the preferred source of information for use in DOE socioeconomic analyses because it provides a greater level of consistency across geopolitical boundaries than most other data sources. Bureau information is based on the direct collection of

information, while other information sources often rely either on some form of the Bureau information or on proxies such as telephone and electrical connections to households and businesses. The information for a particular variable provided by local and state agencies or private vendors can differ, sometimes significantly, because of the use of different methods, source data, level of detail and terminology. In addition, Bureau of the Census information is readily available and updated population estimates are available annually.

In response to comments and recently available information, DOE has updated its population estimates in the regions of influence to reflect the most recent state and local information, as well as the Bureau of the Census 2000 population summary data for Nevada. For the repository- and transportation-related regions of influence, DOE performed REMI simulations to establish an updated population baseline by accounting for population estimates and projections provided by county governments. In the absence of county information, DOE used population estimates and projections from the Nevada State Demographer's Office. The updated population baselines were then used to estimate populations for Clark, Nye, and Lincoln Counties and the Rest of Nevada through 2035. These population projections were compared and adjusted to the 2000 Census population summary data. In this way, model population projections reflected the most recent available information.

To update the health and safety analyses associated with transportation in Nevada, DOE used the baseline population for each county in the region of influence, forecast the population to 2035, and scaled impacts accordingly. For example, if a county's population was estimated to double from 1990 to 2035, DOE assumed that the population along the associated rail corridor also would double and scaled the radiological impacts accordingly. In certain locales, however, such as around the planned Las Vegas Beltway, DOE used local sources of population information to better reflect population growth trends (in this instance, information from a report prepared for the City of North Las Vegas).

On a national basis, DOE scaled the 1990 population-based impacts upward to reflect the relative state-by-state population growth to 2035. The projections are based on 2000 Census data.

In general, public health impacts to populations residing along candidate transportation routes or rail lines would increase directly with an increase in population (from 1990 to 2035 population estimates), if all other factors relevant to estimating such impacts remained constant. However, some factors, such as the number of anticipated rail shipments and the computer model used to estimate the dose to the public during traffic stops, have changed because of new information or in response to comments. For this reason, the health impacts in the Final EIS are similar to, and in some instances less than, those reported in the Draft EIS, despite generally increased population estimates.

Why didn't DOE analyze the impacts associated with the negative perceptions (stigma) attached to a potential repository at Yucca Mountain? The negative perceptions associated with the repository and transportation of radioactive materials would cause people and businesses to avoid places and products, thereby causing a significant adverse impact to the economy of the State of Nevada and local communities that the EIS should evaluate.

During scoping for the EIS, DOE received comments saying that the EIS should analyze perception-based and stigma-related impacts that could arise from the construction and operation of a repository and from the transportation of spent nuclear fuel and high-level radioactive waste. In considering these comments, DOE recognized that perceptions depend on the underlying value systems of the individual forming the perception. Perception-based impacts would not

necessarily depend on the actual physical impacts or risks from repository operations or transportation. Further, people do not consistently act in accordance with negative perceptions, and thus the connection between public perception of risk and future behavior would be uncertain or speculative at best. For these reasons, DOE determined that including analyses of perception-based and stigma-related impacts in the Draft EIS would not provide meaningful information.

Nevertheless, in light of the comments received on the Draft EIS concerning this subject, DOE commissioned a new examination of relevant studies and literature on perceived risk and stigmatization of communities to determine whether the state-of-the-science in predicting future behavior based on perceptions had advanced sufficiently since scoping to allow DOE to quantify the impact of public risk perception on economic development or property values in potentially affected communities. Of particular interest were those scientific and social studies carried out in the past few years that directly relate to either Yucca Mountain or to DOE actions such as the transportation of foreign research reactor spent nuclear fuel. In addition, this examination evaluated the conclusions of previous literature reviews, such as those conducted by the Nuclear Waste Technical Review Board and the State of Nevada, among others. The examination concluded that:

- While in some instances risk perceptions could result in adverse impacts on portions of a local economy, there are no reliable methods whereby such impacts could be predicted with any degree of certainty
- Much of the uncertainty is irreducible, and
- Based on a qualitative analysis, adverse impacts from perceptions of risk would be unlikely or relatively small.

While stigmatization of southern Nevada can be envisioned under some scenarios, it is not inevitable or numerically predictable. Any such stigmatization would likely be an aftereffect of unpredictable future events, such as serious accidents, which are not anticipated to occur. As a consequence, DOE addressed but did not attempt to quantify potential impacts from risk perceptions or stigma in this Final EIS.

VI. ENVIRONMENTAL JUSTICE AND NATIVE AMERICAN ISSUES

DOE did not adequately consider Native American viewpoints. Although the EIS acknowledges Native American viewpoints, DOE did not incorporate these viewpoints into the analyses and resulting conclusions.

DOE believes that it appropriately considered Native American viewpoints by incorporating into the EIS the Native Americans' own identification of potential impacts to historic and other cultural resources important to sustaining and preserving their cultures.

DOE has maintained long-term and ongoing interactions with Native American tribes regarding Yucca Mountain. DOE initiated its Native American Interaction Program in 1987 to consult and interact with tribes and organizations on the characterization of the Yucca Mountain site, and the possible construction and operation of a repository. DOE also interacts cooperatively with the Consolidated Group of Tribes and Organizations, which consists of officially appointed tribal representatives responsible for presenting their tribal concerns and perspectives to the Department.

During the preparation of the EIS, DOE interacted with Native American tribes on a range of topics of interest to assess their viewpoints and perspectives. In addition, DOE supported the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations in its preparation of *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement* (DIRS 102043-AIWS 1998). The results of this report are included in the EIS.

Based on the results of the report, DOE acknowledges in the EIS that people from many Native American tribes have used the area proposed for the repository as well as nearby lands; that the lands around the site contain cultural, animal, and plant resources important to those tribes; and that the implementation of the Proposed Action would continue restrictions on free access to the area around the repository site. Furthermore, the presence of a repository would represent an intrusion into what Native Americans consider an important cultural and spiritual area. These concerns notwithstanding, DOE and the Consolidated Group of Tribes and Organizations recognize that restrictions on public access to the area have been generally beneficial and protective of cultural resources, sacred sites, and traditional cultural properties.

Why is DOE not honoring the Ruby Valley Treaty of 1863 with the Western Shoshone Nation?

A 1985 U.S. Supreme Court decision (*United States v. Dann*, 470 U.S. 39 (1985)) held that the Western Shoshone claim to land associated with the Ruby Valley Treaty has been extinguished, and that fair compensation has been made. The Western Shoshone people maintain that the Ruby Valley Treaty of 1863 gives them rights to 97,000 square kilometers (37,000 square miles) in Nevada, including the Yucca Mountain region. In 1977, the Indian Claims Commission granted a final award to the Western Shoshone people, who dispute the Commission's findings and have not accepted the monetary award for the lands in question. In *United States v. Dann*, the Supreme Court ruled that even though the money has not been distributed, the United States has met its obligations with the Indian Claims Commission's final award and, as a consequence, the aboriginal title to the land has been extinguished.

DOE did not adequately evaluate environmental justice relative to transportation. DOE's two-staged assessment process masks significant impacts to minorities and low-income populations, and its failure to identify either specific locations or specific characteristics of affected communities demonstrates the inadequacy of the analysis.

As required by Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, DOE performs environmental justice analyses to identify and address, as appropriate, the potential for its actions to cause disproportionately high and adverse impacts to minority or low-income populations. The approach to environmental justice analysis in this EIS is consistent with Council on Environmental Quality guidance. The goal of this approach is to identify whether any high and adverse impacts would fall disproportionately on minority and low-income populations. The approach first analyzes the potential impacts on the general population as a basis for comparison. Second, based on available information, the approach assesses whether there are unique exposure pathways, sensitivities, or cultural practices that would result in high and adverse impacts on minority and low-income populations. If such potential impacts could indeed be high and adverse, the approach then compares the impacts on minority and low-income populations to those on the general population to determine whether any high and adverse impacts fall disproportionately on minority and low-income populations. In other words, if high and adverse impacts on a minority or low-income population would not appreciably exceed the same type of

impacts on the general population, no disproportionately high and adverse impacts would be expected.

In response to comments, DOE has reevaluated available information to determine whether the Draft EIS overlooked any unique exposure pathways or unique resource uses that could create opportunities for disproportionately high and adverse impacts to minority and low-income populations, even though the impacts to the general population would not be high and adverse. Additional unique pathways and resources were identified and analyzed, although none revealed a potential for disproportionately high and adverse impacts. For example, DOE estimated the potential health impacts from a subsistence diet based primarily on game taken from lands near the repository exclusion areas and concluded that high and adverse health and safety impacts would be unlikely.

DOE also has updated and refined information germane to its environmental justice analysis. The EIS now includes, for example, additional and more detailed mapping of minority populations, and additional mapping and information that describes the proximity of tribal lands and cultural and ceremonial areas to potential rail corridors in Nevada. Based on the additional information and resulting analysis, DOE has concluded that disproportionately high and adverse impacts from the construction and operation of a rail line or intermodal transfer facility would be unlikely.

DOE's evaluation of health and safety impacts to minority and low-income populations residing along spent fuel and high-level waste transportation routes is inadequate; only an analysis of actual routes on a segment-by-segment basis would allow DOE to substantiate its conclusion that there would be no disproportionately high and adverse health and safety impacts.

DOE fulfills the requirements of Executive Order 12898 by looking first at whether the impacts on minority and low-income populations would be high and adverse, and then whether any potential high and adverse impacts would fall disproportionately on such populations. As discussed below, it is not necessary to examine the composition of the general population residing along existing spent nuclear fuel and high-level waste transportation corridors before DOE can reasonably conclude that there would be no disproportionately high and adverse impacts to minority and low-income populations from the transportation of radioactive materials.

The EIS analyzes potential public health effects of both routine (incident-free) transportation of radioactive materials and transportation accidents involving radioactive materials. First, regarding routine transportation, the EIS considers vehicular air emissions and doses from exposure to radioactive materials during transport. The EIS estimates the impact from air emissions to be 1 emissions-related fatality during the 24-year transportation campaign. The EIS also estimates that the 24-year transportation campaign would cause fewer than about 3 latent cancer fatalities among the public, and fewer under the preferred mostly rail scenario. Although many people would be exposed nationwide over a long campaign, the radiation dose to any exposed individual would be very low. In this context, DOE does not consider such impacts to be high. In addition, DOE does not know of a plausible mechanism under these circumstances whereby low-income or minority populations could incur high and adverse impacts when the general public does not. Because there could be no disproportionately high and adverse impacts on low-income or minority populations, it is not necessary to examine the composition of the population along existing transportation corridors to conclude that the potential public health effects from exposure to radioactive materials during routine transportation do not implicate environmental justice concerns.

The EIS also estimates the number of people in the general public who could be killed by accidents involving transportation of spent fuel and high level waste. The two mechanisms for such impacts are bodily trauma from collisions or exposure to radioactivity that would be released if a sufficiently severe accident were to occur. The EIS estimates that the 24-year transportation campaign would cause fewer than 5 deaths among the general public from trauma sustained in collisions with vehicles carrying spent nuclear fuel or high-level radioactive waste. In this context, DOE does not consider such impacts to be high. Moreover, DOE does not know of a plausible mechanism under these circumstances whereby low-income or minority populations could incur high and adverse impacts when the general public does not.

Only if a severe accident was to occur that resulted in a considerable release of radioactive materials would it be possible for the affected population to sustain high and adverse health effects, but the probability of such an event occurring is remote, so the overall associated risk to the general public is low. Moreover, as is true of all transportation accidents, it is impossible to predict where along a transportation corridor an accident could occur (unlike accidents at fixed-facility locations), and, thus, who might be affected. Therefore, as with routine transportation and trauma effects of accidents, it is not necessary to examine the composition of the population along transportation corridors to conclude that the radiological risk resulting from transportation accidents would not constitute a disproportionately high and adverse impact on low-income or minority populations.

Although the transportation of radioactive materials would not result in disproportionately high and adverse impacts on low-income and minority populations, there are reasons to examine the composition of the population along newly proposed transportation corridors (such as the alternative locations of rail corridors in Nevada) that do not apply to existing highways and railways. In a consideration of where to locate a new transportation corridor, the impacts of the construction and use of a newly created route on land use, socioeconomics, noise, air quality, and aesthetics, to name a few categories, could vary by location. For example, constructing a new highway that might benefit the population as a whole might nevertheless so disrupt a minority or low-income population living along the proposed route as to result in disproportionately high and adverse impacts. Selecting among alternative new routes could offer opportunities to avoid high and adverse impacts that would fall disproportionately on low-income or minority populations relative to the general population that would not be present when considering existing transportation corridors. Therefore, even though the health effects from exposure to radioactive materials from transportation activities would not implicate environmental justice concerns in selecting new routes, other factors could. For these reasons, DOE examined the composition of the population along the five candidate routes for a new rail corridor in Nevada to determine the minority and low-income populations residing along the proposed corridors.

VII. TRANSPORTATION

Why did DOE assume that national shipments would either be by “mostly” rail or by “mostly” legal-weight truck when neither scenario is reasonable?

DOE evaluated the potential environmental impacts from the transportation of spent nuclear fuel and high-level waste from 5 DOE and 72 commercial sites to a potential repository at Yucca Mountain. At this time, many years before shipments to a repository could begin, it is impossible

to predict accurately the number of shipments by either truck or rail. For this reason, DOE evaluated two scenarios for moving the materials to Nevada:

- Transport using mostly legal-weight trucks
- Transport using mostly rail

DOE evaluated these scenarios to ensure that it considered the range of potential environmental impacts associated with the transportation of spent nuclear fuel and high-level radioactive waste.

DOE believes that the mostly rail case, in which more than 95 percent of spent nuclear fuel and high-level radioactive waste would be shipped by rail, would most closely approximate the actual mix of truck and rail shipments. In reaching this conclusion, DOE has assessed the capabilities of the sites to handle larger (rail) casks, the distances to suitable railheads, and historical experience in actual shipments of nuclear fuel, waste, or other large reactor-related components. In addition, DOE considered relevant information published by sources such as the Nuclear Energy Institute and the State of Nevada.

Nonetheless, in response to comments, DOE has analyzed the effects of different mixes of rail and truck shipments. The results of this analysis confirm the Department's estimate that the mostly rail and mostly legal-weight truck scenarios represent a reasonable range (lower and upper bound) of potential environmental impacts from the transportation of spent nuclear fuel and high-level radioactive waste.

Why didn't DOE identify the specific rail and highway routes that will be used to ship spent nuclear fuel and high-level radioactive waste?

At this time, many years before shipments could begin, it is impossible to predict which highway routes or rail lines DOE would use. Before such shipments began, state or tribal governments could designate alternate preferred highway shipping routes, and highways and rail lines could be built or modified.

Therefore, for the analysis in this EIS, DOE selected potential highway routes in accordance with U.S. Department of Transportation regulations, which require the use of preferred routes (typically highways and bypasses that are part of the Interstate Highway System). The Department based its selection of potential rail routes on current rail practices, because there are no comparable Federal regulations applicable to the selection of rail routes for the shipment of radioactive materials.

In response to public comments, DOE has included maps of the representative highway routes and rail lines it used for analysis in the EIS. It also included potential health and safety impacts associated with shipments for each state through which shipments could pass.

The transportation-related public health and safety analysis was inadequate because DOE did not consider community-by-community population characteristics, such as the locations where individuals live and work.

DOE does not believe that it is necessary or appropriate to consider population characteristics on a community-by-community basis to determine potential public health and safety impacts from the transportation of spent nuclear fuel and high-level radioactive waste. The use of widely accepted analytic tools, latest reasonably available information, and cautious but reasonable

assumptions if there are uncertainties, offer the most appropriate means to arrive at conservative estimates of transportation-related public health impacts.

In this EIS, DOE has used computer models it has used in previous EISs and other studies. These models are widely accepted by the national and international scientific and regulatory communities. For instance, DOE selected the RADTRAN 5 computer program to estimate radiological impacts to populations from incident-free transportation and from accidents. RADTRAN, which was originally developed by Sandia National Laboratories in the late 1970s, has been used in many other previous DOE EISs, and it has undergone periodic review and revision. In 1995, an independent review of RADTRAN 4 (immediate predecessor to RADTRAN 5) demonstrated that it yielded acceptable results when compared to “hand” calculations. More recently, an independent review found that RADTRAN 5 overestimates the measured radiation dose to an individual from moving radiation sources.

To ensure that the EIS analyses reflect the latest reasonably available information, DOE has either incorporated information that has become available since the publication of the Draft EIS or modified existing information to accommodate conditions likely to be encountered over the life of the Proposed Action. For example, the analysis in the Draft EIS relies on population information from the 1990 Census. In this Final EIS, DOE has scaled impacts upward to reflect the expected relative state-by-state population growth to 2035, using 2000 Census data.

Although the EIS analyses are based on the latest reasonably available information and state-of-the-art analytic tools, not all aspects of incident-free transportation or accident conditions can be known with absolute certainty. In such instances, DOE has relied on conservative assumptions that tend to overestimate impacts. For instance, DOE assumed that the radiation dose external to each vehicle carrying a cask during routine transportation would be the maximum allowed by U.S. Department of Transportation regulations. Similarly, DOE assumed that a hypothetical individual, the “maximally exposed individual,” would be a resident living 30 meters (100 feet) from a point where all truck shipments would pass. Under these circumstances, the maximally exposed individual would receive a dose of about 6 millirem from exposure to all truck shipments (6 millirem represents an increased probability of contracting a fatal cancer of 3 in 1 million). Although it can be argued that individuals could live closer to these shipments, it is highly unlikely that an individual would be exposed to all shipments over 24 years of shipments to the repository, even though DOE incorporated this highly conservative assumption in the analysis.

However, in response to comments, DOE has considered locations at which individuals could reside nearer the candidate rail corridors and heavy-haul truck routes in Nevada as a way of representing conditions that could exist anywhere in potentially affected communities. For example, DOE assumed that a maximally exposed individual could reside as close as 4.9 meters (16 feet) to a potential heavy-haul truck route. During the 24-year period of repository operations, this maximally exposed individual would receive an estimated dose of about 29 millirem (if exposed to all shipments), resulting in an increased fatal cancer probability of 2 in 100,000.

These exposures would be well below those received from natural background radiation and would not be discernible even if doses could be measured. For comparison, the lifetime likelihood of an individual incurring a fatal cancer from all other causes is about 1 in 4.

Why didn't DOE analyze a range of accidents that reflect real-life conditions?

DOE did analyze a range of accidents that reflect the range of reasonably foreseeable “real-life conditions.” Real-life conditions that would involve various types of collisions, various natural

disasters, specific locations (such as mountain passes), or various infrastructure accidents (such as track failure) in effect constitute a combination of cask failure mechanisms, impact velocities, and temperature ranges, which the EIS does evaluate. Because it is impossible to predict what real-life conditions might be involved in any accidents that could occur, DOE has revised the EIS to describe the maximum reasonably foreseeable accident in terms of cask failure mechanisms and accident forces, and to ensure that the analysis accounts for all reasonably foreseeable real-life conditions. Accident scenarios are modeled in this fashion to accommodate the almost infinite number of variables that any given accident could involve.

In the Draft EIS, DOE considered six categories of increasingly severe and unlikely accident scenarios. The analyses hypothesized one accident scenario to represent each category, along with a corresponding projection of the amount of radioactive material a transportation cask could release. The analyses estimated impacts of postulated releases in three population zones – urban, suburban, and rural – and under two weather conditions – slowly dispersing conditions and moving air conditions. The analyses also estimated impacts from an unlikely but severe accident scenario called a maximum reasonably foreseeable accident.

In the Draft EIS, for example, DOE evaluated the ability of large aircraft components (engines and engine shafts) to penetrate shipping casks. DOE considered both small military aircraft and commercial aircraft at velocities representative of takeoffs and landings and at higher velocities. DOE found that these aircraft components would not penetrate a shipping cask sufficiently to cause a release of radioactive materials.

DOE has revised the transportation accident analyses in the EIS to reflect new information. For example, since the publication of the Draft EIS, the NRC published *Reexamination of Spent Fuel Shipment Risk Estimates*, NUREG/CR-6672 (DIRS 152476-Sprung et al. 2000). DOE has concluded that the models used for analysis in the Draft EIS relied on assumptions about spent nuclear fuel and cask response to accident conditions that caused an overestimation of the resulting impacts.

Based on the revised analyses, DOE has concluded in the EIS that casks would continue to contain spent nuclear fuel fully in more than 99.99 percent of all accidents (of the thousands of shipments over the last 30 years, none has resulted in an injury due to release of radioactive materials). This means that of the approximately 53,000 truck shipments, there would be an estimated 66 accidents, each having less than a 0.01-percent chance that radioactive materials would be released. The chance of a rail accident that would cause a release from a cask would be even less. The corresponding chance that such an accident would occur in any particular locale would be extremely low.

Why didn't the EIS discuss emergency response and accident mitigation? An adequate EIS requires an understanding of the responsibilities for emergency management and response training, accident mitigation, the administration of funds for emergency response assistance, and ultimate liability in the event of a transportation accident.

As discussed in the EIS, accidents involving spent nuclear fuel or high-level radioactive waste shipments could occur. However, only the most highly unlikely accidents (less than 0.01 percent of all accidents) would result in the release of radioactive materials from the transportation casks. DOE has, however, analyzed the potential human health effects from these unlikely transportation accidents. These analyses did not take credit for emergency response and intervention, or other mitigation measures. For this reason, DOE concludes that its estimates of human health effects would not be exceeded, if an accident involving a release of radioactive materials was to occur.

Regardless, in response to comments, DOE has revised the EIS to provide information on emergency response responsibilities. Under the NWPA, DOE is required to provide technical and financial assistance to states for training of public safety officials of appropriate units of local government and Native American tribes through whose jurisdictions it plans to transport spent nuclear fuel and high-level radioactive waste. However, state and tribal governments have primary responsibility to respond to and protect the public health and safety in their jurisdictions in accidents involving radioactive materials.

DOE also has revised the EIS to include information on accident liability and to clarify the applicability of the Price-Anderson Act in the event of a nuclear incident. This Act establishes a system of private insurance and Federal indemnification providing as much as \$9.43 billion to compensate for damages or injuries suffered by the public.

Will DOE conduct full-scale testing of the transportation casks?

The NWPA requires DOE to use casks certified by the NRC when transporting spent nuclear fuel and high-level radioactive waste to a repository. The Commission's certification regulations indicate that cask testing must represent the kinds of forces that a cask would encounter in a severe transportation accident. A cask's ability to survive the tests prescribed by the regulations (10 CFR Part 71) can be demonstrated either through component analysis or through scale-model and full-scale testing to demonstrate and confirm the performance of the casks. The NRC would decide which level of physical testing or analysis was appropriate for each cask design submitted.

VIII. REPOSITORY DESIGN AND LONG-TERM PERFORMANCE

Why didn't DOE analyze the latest design in the Draft EIS?

In the Draft EIS, DOE evaluated a preliminary design based on the *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998) that focused on the amount of spent nuclear fuel (and associated thermal output) that DOE would emplace per unit area of the repository (called *areal mass loading*). Areal mass loading was represented in the Draft EIS by three thermal load scenarios: a high thermal load of 85 metric tons of heavy metal (MTHM) per acre, an intermediate thermal load of 60 MTHM per acre, and a low thermal load of 25 MTHM per acre. The purpose of these scenarios was not to place a limit on the choices among alternative designs because, as stated in the Draft EIS, DOE expected the repository design to continue to evolve in response to ongoing site characterization and design-related evaluations. Rather, DOE selected these analytical scenarios to represent the range of foreseeable design features and operating modes, and to ensure that it considered the associated range of potential environmental impacts.

Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would reduce uncertainties in or improve long-term repository performance, and improve operational safety and efficiency. The result of the design evolution process was the development of the *flexible design* (which the Supplement to the Draft EIS called the Science and Engineering Report Flexible Design). Although this design focuses on controlling the temperature of the waste package surface and the rock between the waste emplacement drifts (as opposed to areal mass loading), the basic elements of the Proposed Action to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain remain unchanged since the Draft EIS. DOE evaluated the flexible design in the Supplement to the Draft EIS, which it issued for public review and comment in May 2001.

This Final EIS addresses all aspects of the Proposed Action, including the flexible design. DOE acknowledges in the EIS that it could modify or refine the flexible design further during the license application process, if the site was approved for development.

DOE doesn't understand the hydrologic setting. There exist sufficient uncertainties and a lack of understanding of such fundamental factors as the relationships between the underlying aquifer of interest and the overlying geologic units that DOE should continue to study the geohydrologic setting at the site and surrounding region.

DOE believes that it has sufficient information and understanding of the hydrologic setting to make an adequate determination of the potential environmental impacts from the Proposed Action. DOE, the U.S. Geological Survey, and others have been evaluating and assessing the hydrologic setting and associated characteristics at the Yucca Mountain site and nearby region for more than two decades. During this time DOE has modified its site characterization program to reflect new information and assessments and to accommodate reviews by independent parties, both internal and external to the Department. Nevertheless, DOE recognizes that additional information would refine its understanding of the regional groundwater flow system, and would reduce uncertainties associated with flow and transport in the alluvial, volcanic, and carbonate aquifers.

To obtain additional information, DOE has supported Nye County in the Early Warning Drilling Program to characterize further the saturated zone along possible groundwater pathways from Yucca Mountain as well as the relationships among the volcanic, alluvial, and carbonate aquifers. Information from the ongoing site characterization program (and possible Testing and Performance Confirmation Program, which is described below) would be used in conjunction with that of the Early Warning Drilling Program to refine the Department's understanding of the flow and transport mechanics of the saturated alluvium and valley-fill material south of the proposed repository site, and to update conceptual and numerical models used to estimate waste isolation performance of the repository. When DOE published the Draft EIS, only limited information from the Early Warning Drilling Program was available. Since then, however, this program has gathered additional information, which DOE has incorporated in the EIS.

In addition, DOE has installed a series of test wells along the groundwater flow path between the Yucca Mountain site and the Town of Amargosa Valley as part of an alluvial testing complex. The objective of this program is to better characterize the alluvial deposits beneath Fortymile Wash along the east side of Yucca Mountain. Single- and multi-well tracer tests have begun and the results thus far have strengthened the basis of the site-scale saturated flow and transport model. Information from this program has been incorporated in the EIS.

DOE has begun to implement a *Testing and Performance Confirmation Program*, elements of which address the hydrologic system. The purpose of this program is to evaluate the accuracy and adequacy of the information used to determine whether the repository would meet long-term performance objectives. The Testing and Performance Confirmation Program, which would continue through closure of the repository (possibly as long as about 300 years), would offer a means to further understanding of the hydrologic system and to reduce uncertainties.

The Yucca Mountain site should be discarded because subsurface fracturing will allow contaminated groundwater to reach humans in less than 1,000 years, thus meeting the disqualifying condition established by DOE in its guidelines (10 CFR 960.4-1).

As discussed above, DOE's original 1984 site suitability guidelines (10 CFR Part 960) have been superseded by Yucca Mountain-specific guidelines (10 CFR Part 963) promulgated by DOE in 2001. Even though 10 CFR Part 960 no longer applies to Yucca Mountain, DOE believes that information and analyses do not support a finding that the site would have been disqualified under the groundwater travel time disqualifying condition at 10 CFR 960.4-2-1(d). Under that condition, a site would be disqualified if the expected groundwater travel time from the disturbed zone (the area in which properties would change from construction or heat) to the accessible environment would be less than 1,000 years along any pathway of likely and significant radionuclide travel. The definition of groundwater travel time in 10 CFR 960.2 specifies that the calculation of travel time is to be based on the average groundwater flux (rate of groundwater flow) as a summation of travel times for groundwater flow in discrete segments of the system. (In this case, the geologic and hydrologic subunits comprising the unsaturated and saturated zones.) As a practical matter, this definition provides for the consideration of the rate at which most of the water moves through the natural system to the accessible environment.

As part of its site characterization activities, DOE has undertaken various studies to identify and consider characteristics of the unsaturated (above water table) and saturated (water table) zones, such as the flow of water and transport of radionuclides, that are relevant to analyzing groundwater travel times. DOE also has considered physical evidence such as the chemistries and ages of water samples from these zones. Because of the inherent uncertainties in understanding such natural processes as groundwater flow, DOE has developed numerical models to represent an approximation of these processes and to bound the associated uncertainties.

Based on these models, which incorporate the results of these studies and available corroborating physical evidence, DOE estimates that the median groundwater travel times would be about 8,000 years, and average groundwater travel times would be longer. These models indicate that small amounts of water potentially moving in "fast paths" from the repository to the accessible environment could do so in fewer than 1,000 years. However, the models and corroborating physical evidence indicate that most water would take substantially longer than 1,000 years to reach the accessible environment. Given this, DOE believes that the site would not have been disqualified under the groundwater travel condition at 10 CFR 960.4-2-1.

How can DOE possibly predict repository performance given the uncertainties associated with the lack of data, untested computer models and chaotic nature of the long-term processes involved?

DOE acknowledges that it is not possible to predict with certainty what will occur thousands of years into the future. The National Academy of Sciences, the EPA, and the NRC also recognize the difficulty of predicting the behavior of complex natural and engineered barrier systems over long periods. The NRC regulations (see 10 CFR Part 63) acknowledge that absolute proof is not to be had in the ordinary sense of the word, and the EPA has determined (see 40 CFR Part 197) that reasonable expectation, which requires less than absolute proof, is the appropriate test of compliance.

DOE, consistent with recommendations of the National Academy of Sciences, has designed its performance assessment to be a combination of mathematical modeling and natural analogues. Performance assessment explicitly considers the spatial and temporal variability and inherent

uncertainties in geologic, biologic and engineered components of the disposal system and relies on:

- a. Results of extensive underground exploratory studies and investigations of the surface environment.
- b. Consideration of features, events and processes that could affect repository performance over the long-term.
- c. Evaluation of a range of scenarios, including the normal evolution of the disposal system under the expected thermal, hydrologic, chemical and mechanical conditions; altered conditions due to natural processes such as changes in climate; human intrusion or actions such as the use of water supply wells, irrigation of crops, exploratory drilling; and low probability events such as volcanoes, earthquakes, and nuclear criticality.
- d. Development of alternative conceptual and numerical models to represent the features, events and processes of a particular scenario and to simulate system performance for that scenario.
- e. Parameter distributions that represent the possible change of the system over the long term.
- f. Use of conservative assessments that lead to an overestimation of impacts.
- g. Performance of sensitivity analyses.
- h. Use of peer review and oversight.

DOE is confident that its approach to performance assessment addresses and compensates for various uncertainties, and provides a reasonable estimation of potential impacts associated with the ability of the repository to isolate waste over thousands of years.

Earthquakes and volcanoes will cause releases of radioactive waste.

DOE has analyzed the potential public health and safety impacts that could arise from natural events such as earthquakes and volcanic activity. The disruptive nature of earthquakes and volcanic activity differ materially, both in terms of probabilities (likelihood of occurrence) and the possible disruptive nature of the events themselves. Volcanism over the long-term life of the repository, with eruptions and magma flow, would be highly unlikely, while seismic activity and its consequent ground motion would be more likely to occur.

While the occurrence of events cannot be predicted exactly, risks can be estimated statistically. Computer simulations allow DOE to estimate risks from natural events. Thus, the EIS contains an analysis of the probabilities and effects of such events on radionuclide release, and the resultant potential human health impacts to the public.

Sudden displacements along faults, and the resulting earthquakes, could affect the repository in two ways: (1) seismic shaking could damage surface facilities and subsurface engineered barriers resulting in the release of radioactive materials, and (2) ruptures along faults at Yucca Mountain could provide pathways for water flow and radionuclide migration to the underlying aquifer. Earthquakes potentially would have the greatest impact on surface facilities during operations, but DOE would design each structure to withstand the ground movement associated with severe earthquakes. Regardless, DOE estimated the potential impacts that could result from a “beyond-

design-basis” seismic event that would result in the collapse of the Waste Handling Building and consequent damage to spent nuclear fuel assemblies. DOE determined that the resulting impacts associated with this scenario would be small (primarily due to the physical form of the assemblies, reduced releases due to the building rubble, and distance to the nearest population).

The underground-engineered barriers (primarily waste packages and drip shields) would be less susceptible to damage from rockfalls because of their structural integrity and size. The nature of the rock in the proposed repository is such that rockfalls would be limited in terms of the size and number of rocks that fall. DOE has determined that the drip shields overlying the waste packages would be likely to withstand rockfalls over the first 10,000 years of emplacement, thereby protecting the waste packages.

Volcanic eruptions with magma flow into the emplacement drifts could result in the release of volcanic ash and entrained waste into the atmosphere. These events could damage the waste packages and result in a release to the environment. DOE estimated the potential impacts on the nearest population conservatively (tending to overestimate), assuming the direction and speed of wind transport of an ash plume and determined that the potential for public health and safety impacts would be very small. DOE also determined that magma flows would have minimal impacts on the long-term performance of the repository.

Based on these analyses, DOE concluded that the releases and resulting exposures from seismic or volcanic activity in the event of either an earthquake or a volcanic eruption would be within the standards set by the EPA and the NRC.

Because of the long-lived nature of spent nuclear fuel and high-level radioactive waste, DOE's performance assessment should consider future changes to society, human knowledge and language, and other human-related features.

DOE's total system performance assessment was guided by the radiation protection standards established by the EPA (40 CFR Part 197) and the NRC (10 CFR Part 63). The EPA standards provide, for instance, that DOE should not estimate future changes to society, the biosphere (other than climate), human biology, or human knowledge or technology. Rather, these factors should remain constant over time and should be considered as they existed at the time of assessment. In contrast, however, these standards require the DOE performance assessment to vary factors related to the geology, hydrology, and climate, based on cautious but reasonable assumptions of the changes that could affect the proposed repository over the next 10,000 years.

Societal changes will occur. However, DOE (and the National Academy of Sciences, NRC, and EPA) believe it impossible to predict the extent and magnitude of such changes, because speculation about future society and lifestyle variations can be endless and are not scientifically supportable. Rather, DOE has included conservative assumptions and scenarios, such as climatic change, into its analyses to accommodate the inherent uncertainties associated with estimating repository performance over the long term. DOE's confidence in its performance assessment is enhanced by its adherence to the principles of safety margin and the defense-in-depth that are provided by the multiple natural and engineered barriers included in the base design and its recent enhancements (the flexible design).

In any event, after closure of the repository, DOE would be responsible for maintaining institutional control over the site as required by the NRC. The framework for DOE's program for continued oversight and a postclosure monitoring program is described below.

DOE should commit to a long-term program to monitor the repository after closure.

DOE would design and implement a postclosure monitoring program in compliance with the NRC regulations (10 CFR Part 63). Before closure, DOE would submit a license amendment to the NRC for review and approval. The license amendment application would include, among other items:

- a. An update of the assessment of the performance of the repository for the period after closure
- b. A description of the postclosure monitoring program
- c. A detailed description of the measures to be employed to regulate or prevent activities that could impair the long-term isolation of the waste, and to preserve relevant information for use by future generations

The application also would describe DOE's proposal for continued oversight to prevent any activity at the site that would pose an unreasonable risk of breaching the repository's engineered barriers, or increase the exposure of individual members of the public to radiation beyond limits allowed by the NRC. DOE has modified the EIS to include the types of monitoring and other institutional controls that would be contemplated. However, the Department would define the details of this program during the consideration of the license amendment for closure. This would allow the Department to take advantage of new technological information, as appropriate.

Organization of the Comment-Response Document

This Comment-Response Document contains the comments received on the Draft EIS and the Supplement to the Draft EIS and the DOE responses to them.

DOE extracted the individual comments from all other comment documents and categorized them according to the topical outline prepared for this Comment-Response Document. Because a number of comments were similar in nature, the Department summarized them. The chapters of this document contain every comment DOE received (either in summaries or individually) and the DOE responses, as follows:

- Chapter 1 Proposed Action
- Chapter 2 Nuclear Waste Policy Act
- Chapter 3 National Environmental Policy Act
- Chapter 4 Other Legal, Regulatory, and Policy Issues
- Chapter 5 Alternatives
- Chapter 6 Spent Nuclear Fuel and High-Level Radioactive Waste
- Chapter 7 Repository Design, Performance, and Affected Environment
- Chapter 8 Transportation Modes, Routes, Affected Environment, and Impacts
- Chapter 9 No-Action Alternative
- Chapter 10 Cumulative Impacts
- Chapter 11 Impact Mitigation and Compensation
- Chapter 12 DOE Credibility

Chapter 13 contains comments that DOE received that are outside the scope of this EIS, and responses to those comments as appropriate.